

# Endovascular Surgery for Ruptured Aneurysms with Vasospasm

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## Summary

*With the existence of vasospasm, it is recommended that direct clipping surgery for a ruptured aneurysm be delayed until its disappearance, but this may be associated with aneurysmal re-rupture resulting in a poor outcome for the patients. Indications for endovascular coil embolization in such cases are discussed.*

*Since November in 2003, we have applied endovascular coil embolization in 11 consecutive patients with ruptured aneurysms and apparent vasospasm of the parent artery from two to 17 days (average: eight days) after initial subarachnoid hemorrhage. Three patients had aneurysmal re-rupture before treatment, but the other eight had only experienced the one episode of subarachnoid hemorrhage. With one exception, all endovascular procedures could be successfully performed, resulting in complete occlusion of aneurysms and remarkable dilatation of inserted spastic vessels without technical complications or aneurysmal re-rupture.*

*For the one case of failure because of a tortuous artery, direct clipping surgery was performed after disappearance of vasospasm. Cerebral infarction occurred in four, but only one correlated with the distribution of catheterization, and neurological deficits had completely disappeared three months after the onset. This preliminary report concerning a small number of patients suggests that endovascular coil em-*

*bolization is not contra-indicated for aneurysms with vasospasm requiring catheterization. A large study for confirmation is now warranted.*

## Introduction

Vasospasm appears most frequently from about 3 to 15 days after subarachnoid hemorrhage (SAH) and can severely impair cerebral blood flow and even cause cerebral infarcts<sup>1</sup>. Surgery during the spasm period is therefore regarded as contra-indicated, particularly in cases with higher Hunt & Hess grades<sup>2</sup>, and is therefore recommended early<sup>3</sup> (before) or late<sup>4-6</sup> (after) the spasm period.

## Patient and Methods

Since November in 2003, 11 consecutive patients with ruptured aneurysms and apparent vasospasm underwent endovascular coil embolization in our facilities during the spasm period ranging from two to 17 days (average: eight days) after the initial SAH (Table 1). One was for middle and nine were for anterior cerebral artery aneurysms. The remaining one was a vertebral artery aneurysm. Three patients had aneurysmal re-rupture before treatment, but the other eight had experienced only the single episode of SAH. The reason for treatment delayed more than three days after hemorrhage was delayed admission in five (cases 1,2,3,8 and

9), delayed diagnosis in two (case 5 and 11), adding coil embolization in one (case 4) and uncontrollable intra-cerebral pressure with grade V in one (case 6). Hunt & Hess grade on admission was I~III in seven, IV in two and V in two. Outcome was defined by Glasgow Outcome Scale (GOS) at three months after onset. In two cases (case 3 and case 8) with severe vasospasm in bilateral distal ACA territories, total dose 40 mg of papaverine hydrochloride was administered into ACA to reduce vasospasm. Pre-ictal neurological condition in case 3 had been already poor as bedridden because of symptomatic multiple infarction in bilateral basal ganglia. Case 8 showed acutely progressive disturbance of consciousness immediately after the admission. Remarkable brain edema with midline shift has already been evident on CT before treatment. Spasmolysis using 40 mg /10 ml (0.4%) papaverine solution was administered into A1 portion in both patients. In the other eight patients, spasmolysis was not applied.

### Representative cases

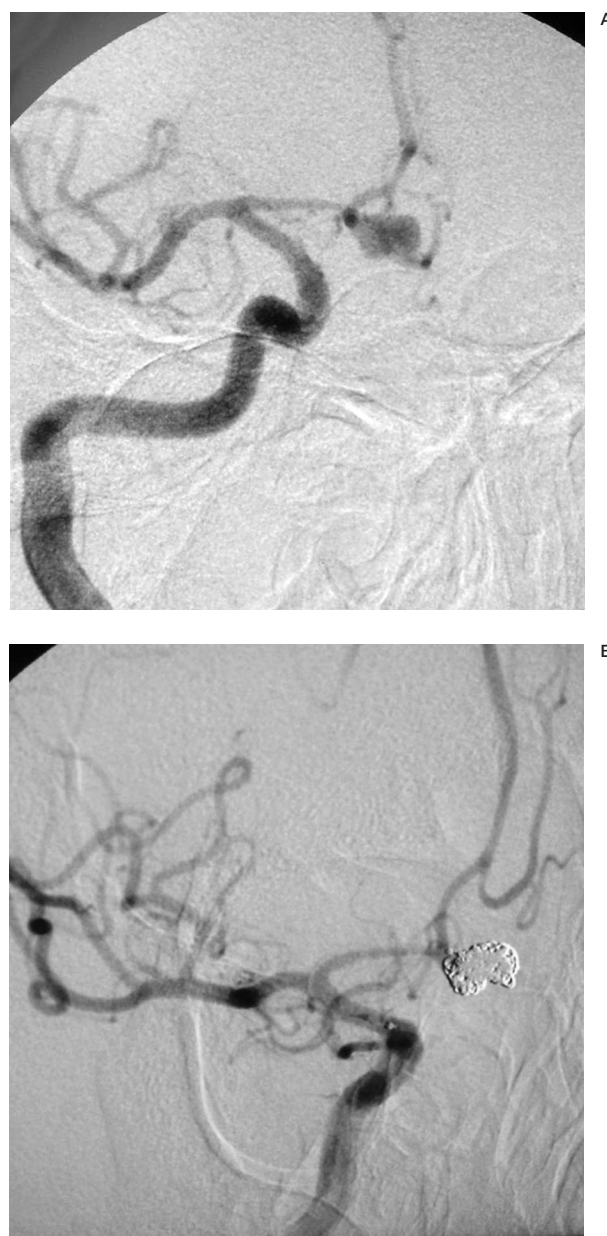
#### Case 1

A 50-year-old man suffered sudden onset of headache, and thereafter mild headache persisted. Five days later he was admitted to our institute. The H& H grade was I. Brain CT showed SAH and cerebral angiography revealed a right anterior cerebral artery (ACA) aneurysm (A1-A2 junction) with vasospasm involving the right internal carotid artery and ACA (figure 1A).

Endovascular surgery was advocated. An Excursio SL 10 microcatheter (Boston Co, USA) preceded by Agility 10 soft tip guide wire (Cordis Europe, N.V) was successfully introduced into the aneurysm, which then could be obliterated completely (figure 1B). Brain infarction occurred on the opposite side of the left fronto-temporal lobe. The case was MD on the Glasgow-Outcome Scale.

#### Case 2

A 60-year-old man suffered sudden onset of headache and vomiting, and thereafter gradually developed disorientation. Nine days later he was admitted to our institute. The H& H grade was II. Computed tomography showed no remarkable SAH, but magnetic resonance flair image showed SAH. Angiography demonstrat-



**Figure 1** (Case 1) Left) and B) to right carotid angiogram showing a right anterior cerebral artery (ACA) aneurysm with vasospasm involving the right internal carotid artery and ACA. B) A right carotid angiogram after embolization showing complete obliteration of the aneurysm and remarkable dilatation of inserted spastic vessels.

ed right ACA aneurysm (A1-A2 junction) with vasospasm involving the right ACA (figure 2A). Endovascular surgery was advocated. Excursio SL 10 microcatheter (Boston Co, USA) preceded by Agility 10 soft tip guide wire (Cordis Europe, N.V) was successfully introduced into the aneurysm, which the could be

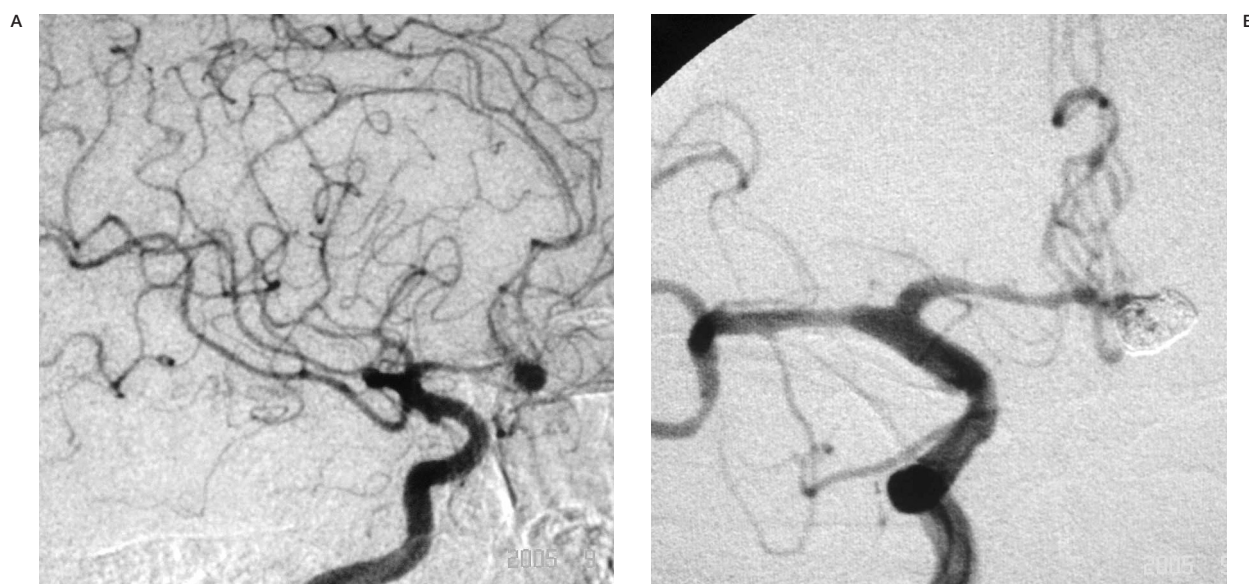


Figure 2 (Case 2) Left) and B) to right carotid angiogram showing a right ACA aneurysm with vasospasm involving the right internal carotid artery and ACA. B) A right carotid angiogram after embolization showing complete obliteration of the aneurysm and remarkable dilatation of inserted spastic vessels.

obliterated aneurysm completely (figure 2B). No brain infarction occurred and the clinical course was uneventful

## Results

All but one of the endovascular procedures could be successfully performed resulting in complete occlusion of aneurysms and remarkable dilatation of inserted spastic vessels (Table 1). Technique-related complications did not occur. With one patient (case 11) endovascular surgery failed because of tortuous parent vessels, and clipping surgery was conducted after disappearance of vasospasm.

Cerebral infarction occurred in four, but only one (case 5) had a new episode in the area correlated with distribution of catheterization, and the neurological deficit completely disappeared three months after the onset. In another two (case 1 and 6) infarction occurred in different sites. The remaining one (case 8) already showed brain edema with midline shift on CT and anisocoria before treatment. In five out of six, successfully treated by endovascular surgery, with H&H grade I-III on admission, GOS exhibited good recovery (GR), but one (case 3) remained in a vegetative state (VS). Case 3 had a history of multiple infarction in bilateral basal ganglia three years previously. Rather

than the spasmolysis, a newly developed multi-infarction due to vasospasm in left fronto-temporal lobe and right occipital lobe caused the unfavorable clinical outcome. One case (case 5) of grade IV recovered to GR, but the other (case 8) died. In case 8, anisocoria occurred just before treatment and CT showed extensive brain edema with midline shift. Coil embolization for aneurysm followed by spasmolysis was successfully performed, but failed to prevent infarction resulted in massive brain swelling. Two with grade V resulted in VS in one (case 6) due to by primary damage and death due to sepsis in the other (case 10).

## Discussion

To our knowledge there have been no reports of evaluation of pure effects of catheterization on spastic vessels after SAH. In this series, majority patients were has treated without spasmolysis, which means pure effect of catheterization on spastic vessels after SAH. Wanke I et Al<sup>7</sup> first reported two cases with ruptured aneurysms successfully treated by coil embolization via spastic vessels followed by spasmolysis. They mentioned that spasms are still significant after aneurysm embolization. Following spasmolysis using papaverine hydrochloride marked dilatation of the spastic

Table 1 Summary of ruptured aneurysms with vasospasm treated with endovascular coil embolization.

Cases No	Age/ Sex	Location of aneurysm	H&H grade	Days after initial SAH	Times of re-rupture	Location of vasospasm	Endo-vascular surgery	GOS
1	50M	rt A1-A2	I	Day 5	0	rt IC, rt ACA	successful	GR
2	60M	rt A1-A2	II	Day 11	0	rt A1	successful	GR
3	57M	rt A1-A2	III	Day 6	1	bil ACA	successful	VS
4	56F	lt A1-A2	III	Day 15	0	bil A1-A2	successful	GR
5	32M	rt A1-A2	IV	Day 16	1	rt ACA	successful	GR
6	75F	lt A1-A2	V	Day 8	2	bil A2	successful	VS
7	51M	lt A1-A2	III	Day 2	0	lt A1	successful	GR
8	39M	A com.	IV	Day 5	0	lt A1, bil. A2, MCA	successful	D
9	76M	lt MCA bifurcation	I	Day 6	0	lt M1	successful	GR
10	46F	lt VA-PICA	V	Day 3	0	BA, lt VA	successful	D*
11	59F	rt A1-A2	III	Day 17	0	bil. A1-A2	failed	MD

*H&H: Hunt and Hess, GOS: Glasgow Outcome Scale, SAH: subarachnoid hemorrhage, GR: good recovery, MD: moderately disabled, SD: severely disabled, VS: vegetative survival, D: dead, IC: internal carotid artery, ACA: anterior cerebral artery, Acom: anterior communicating artery, MCA: middle cerebral artery, VA: vertebral artery, PICA: posterior inferior cerebellar artery, \* DIC from sepsis*

vessels was achieved, but this obscured any pure effect of catheterization to spastic vessels. In a small number of present series, spastic vessels showed marked dilatation after catheterization and in only one case did infarction occur within the distribution field of the catheterized spastic vessels.

Wikholm et Al<sup>8</sup> reported endovascular surgery itself not to have an influence on the occurrence of vasospasm among patients treated within first two days or the spasm period (days 3-14). Murayama et Al<sup>9</sup> also reported endovascular surgery with acute aneurysmal SAH to not have an unfavorable impact on cerebral vasospasm compared with conventional surgery (clipping and cisternal drainage).

In the present series, the success rate for aneurysms by catheterization via apparent vasospastic vessels was 91%, almost the same as 88% reported by Hope et Al<sup>10</sup>. Under spasm of

the parent artery, endovascular coil embolization thus allows satisfactory obliteration of aneurysms without aggravation of vasospasm. Byrne et Al<sup>11</sup> mentioned that patients treated endovascularly within six days of SAH had better outcomes than those treated later, so that intervention should be as soon as possible after presentation.

On the other hand, it is recommended that surgery during vasospastic interval, days 4-10 following SAH, be undertaken with caution, owing to the possibility of aggravating latent cerebral ischemia, especially in the presence of significant cerebral vasospasm determined either by angiography or by cerebral blood flow studies<sup>5</sup>.

Wanke's reported two aneurysms successfully treated with coils followed by intra-arterial infusion of papaverine to treat vasospasm as one-stage procedure. However, intra-arterial



infusion of papaverine solution is not always effective for vasospasm after SAH. Discrepancies between angiographical and clinical improvement have been reported by many authors<sup>12-15</sup>, and about 50% of patients with angiographical improvement show clinical improvement<sup>15,16</sup>. Some patients may have sustained irreversible ischemic injury prior to papaverine treatment<sup>14</sup>. Jin et Al<sup>17</sup> reported paradoxical effects such as a vasoconstrictor response to papaverine at the microvascular level. Aggravated microvascular vasospasm may explain the common observation of a lack of correlation between angiographical and clinical benefit. Clyde et Al<sup>18</sup> reported paradoxical aggravation of vasospasm in the distal MCA and the ACA territories during intra-arterial papaverine treatment. The other explanation for the discrepancy is that papaverine may only exert transient effects. Another possible mechanism is steal of cerebral blood flow from the affected vascular area.

In this series, only two patients received spasmolysis. In one, the territory of spasmolysis did not suffer infarction. In the other case, extensive and remarkable ischemic change on pre-treatment CT had resulted in massive infarction. This patient presumably sustained irreversible ischemic injury prior to papaverine treatment. However, various adverse effects of papaverine have already been reported so that it remains possible that the spasmolysis had a negative effect, because brain edema acutely progressed after treatment.

From this small number of cases, coil embolization for aneurysms via spastic vessels is a safe and effective treatment. Subsequent spasmolysis using papaverine may be of doubtful efficacy because vessels after catheterization consistently showed dilatation, as with post-percutaneous angioplasty. Data with a larger number of cases are now needed to confirm indications for endovascular surgery for the treatment of aneurysms with vasospasm.

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